Figure 1

[see source]

22

Figure 2

[see source for figure]

Automatic transmission control
unit and first clutch actuator

Second clutch actuator

Power supply

Hydraulic release system

Partially hydraulic
release system

Transmission actuator
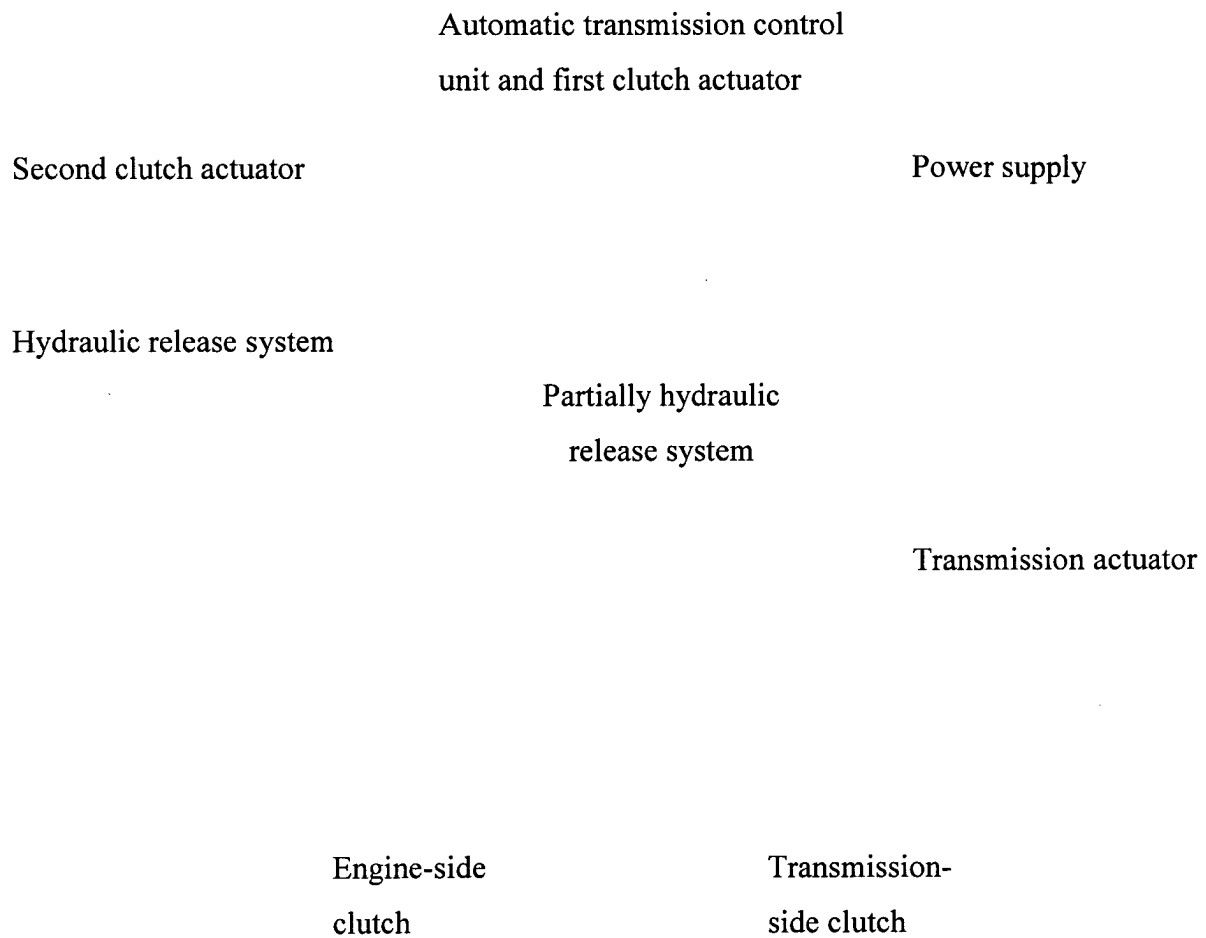
Engine-side
clutch

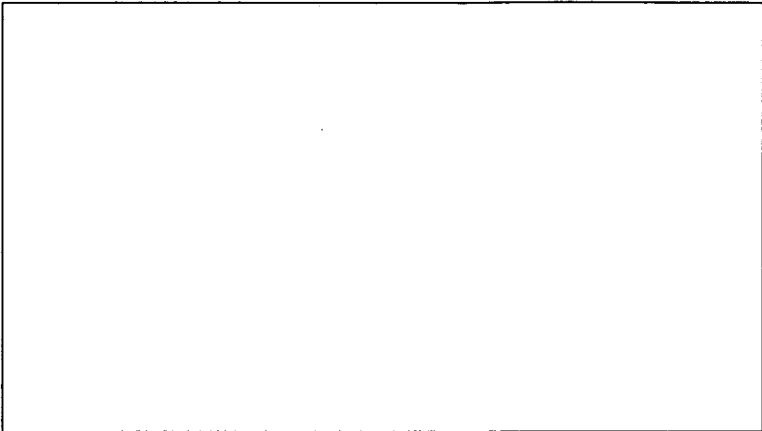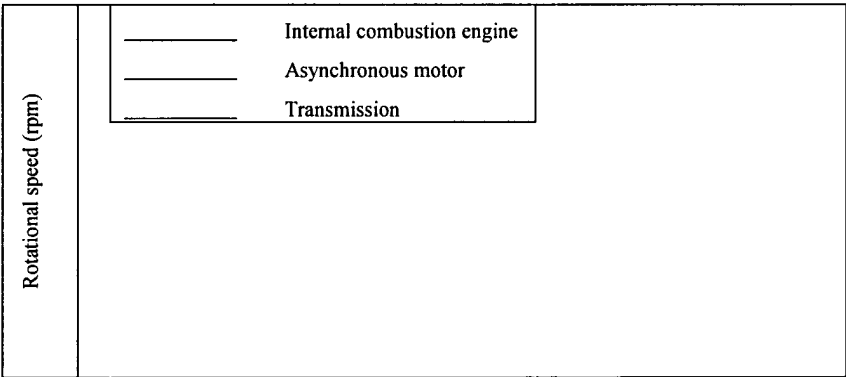Transmission-
side clutch

Figure 3

[see source for figure]

Figure 4

[see source for figures]

Start-up or opening up: severe jolt

Time (s)

	Internal combustion engine
	Asynchronous motor
	Transmission

Rotational speed (rpm)

Time (s)

	Internal combustion engine
	Engine-side clutch
	Asynchronous motor
	Transmission-side clutch

Rotational torque (Nm)

Time (s)

25
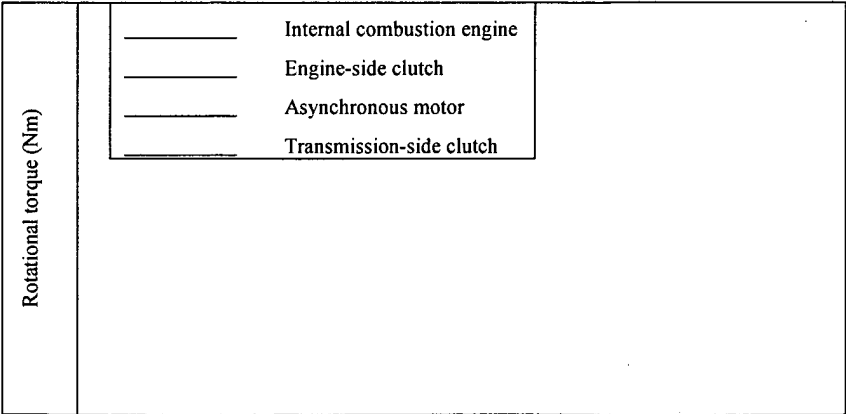
Figure 5

[see source for figures]

Start-up or opening up: severe jolt

Time (s)

	Internal combustion engine
_____	Internal combustion engine
_____	Asynchronous motor
_____	Transmission

Rotational speed (rpm)

Time (s)

_____	Internal combustion engine
_____	Engine-side clutch
_____	Asynchronous motor
_____	Transmission-side clutch

Rotational torque (Nm)

Time (s)

26
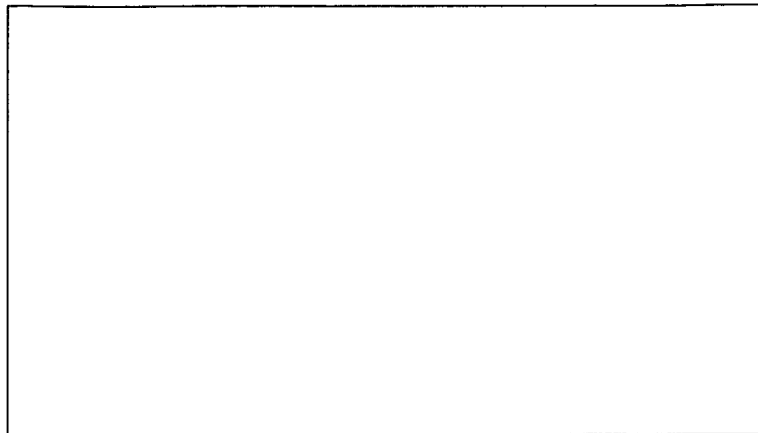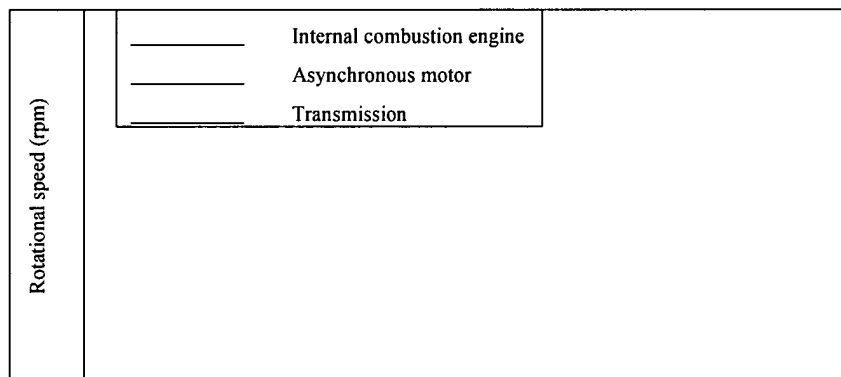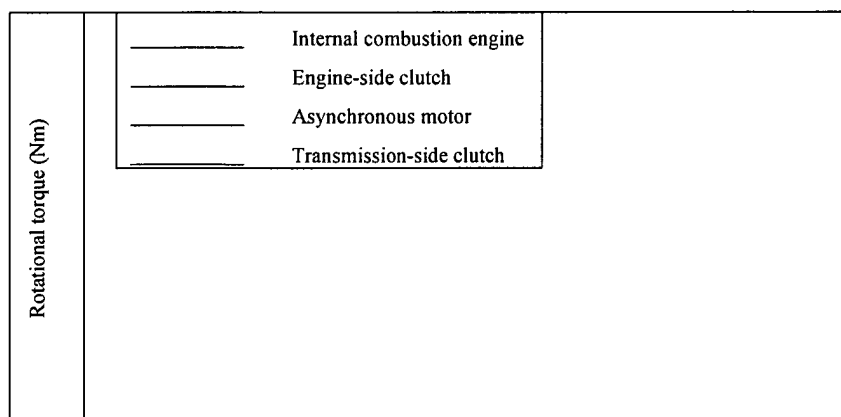
Figure 6

[see source for figure]

Driver's intent

Simulation of
start-up with
electrical motor

Drive train coordinator
– Select gear, specify setpoint gear
– Select motor
– etc.

Start-up
parameters

Internal combustion
engine control

Electric motor control

Transmission control

Clutch control
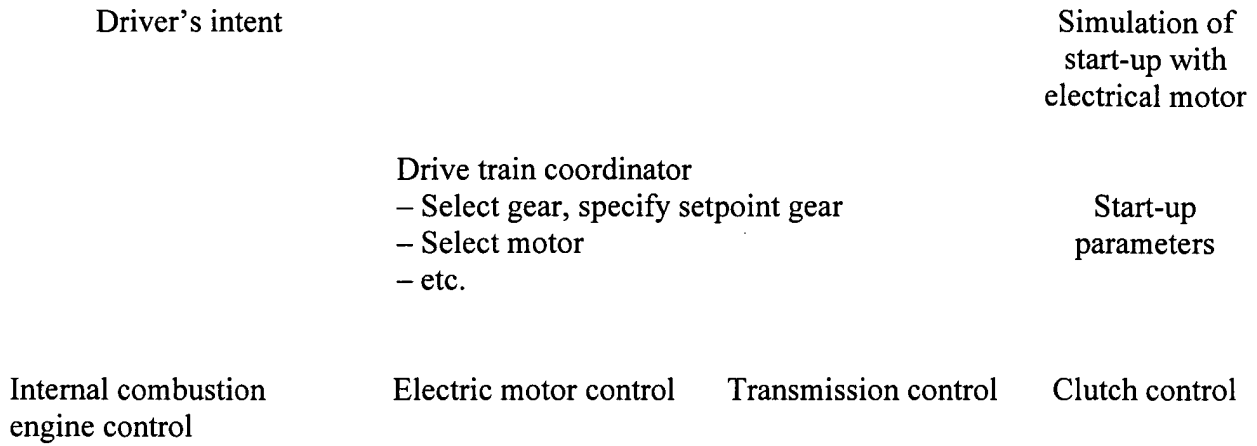
Control system subprograms relevant to start-up

Figure 7

[see source for figure]

```
┌─────────────────────────────┐
│            Start            │
└─────────────────────────────┘


┌─────────────────────────────┐          No
│   Start-up with electric    │
│  motor or standstill with   │
│    internal combustion      │
│         engine off          │
└─────────────────────────────┘
              Yes

┌─────────────────────────────┐          No
│       Pedal value > 0       │
└─────────────────────────────┘
              Yes

┌─────────────────────────────┐     ┌─────────────────────────────┐
│      Determination of       │     │   Virtual rotational speed  │
│      virtual torque of      │     │   of internal combustion    │
│    internal combustion      │     │      engine equal to idle   │
│          engine             │     │       rotational speed      │
└─────────────────────────────┘     │                             │
                                    │        (Creep with          │
┌─────────────────────────────┐     │       electric motor)       │
│      Determination of       │     └─────────────────────────────┘
│   virtual rotational speed  │
│   of internal combustion    │
│          engine             │
└─────────────────────────────┘

┌─────────────────────────────┐
│   Virtual clutch setpoint   │
│    torque from start-up     │
│      characteristic map     │
│        Clutch control       │
└─────────────────────────────┘

┌─────────────────────────────┐
│      Send to electric       │
│        motor control        │
└─────────────────────────────┘

┌─────────────────────────────┐
│            End              │
└─────────────────────────────┘
```

Program sequence for computing electric motor start-up torque